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Volume 9, Number 3, Summer 1988

Critique of Guidelines Proposed for Medical Evaluation Procedures by the CCOHS

Arsenic Exposure and Absorption in Underground Miners in an Ontario Gold Mine

Alternative Method for BSFTPM Determination in Airborne Coke Oven Emissions

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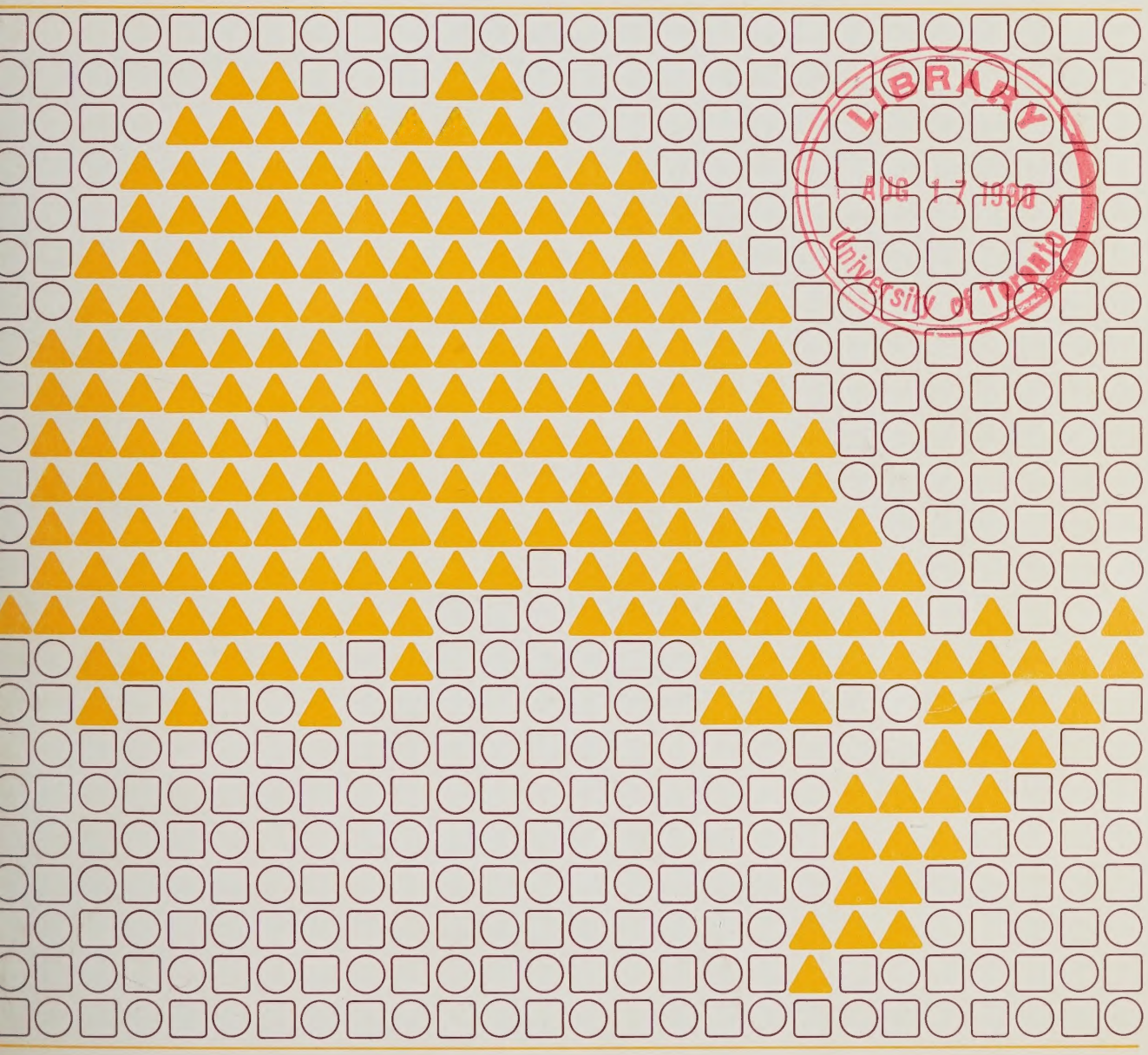

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Occupational Health in Ontario

Volume 9, Number 3, Summer 1988

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2. Murphy S. Pesticides. In: Doull J, Klaassen CD, Amdur MO, eds. Casarett and Doull's Toxicology. 2nd ed. New York: Macmillan, 1980: 357-408.
3. U.S. Department of Health, Education and Welfare. Smoking and Health. A report of the U.S. Surgeon General, 1979.

Tee L. Guidotti, M.D., M.P.H., C.C.B.O.M.

Critique of Guidelines Proposed for Medical Evaluation Procedures by the CCOHS

Summary

Dr. Atherley's philosophy in respect of the potential conflict between individual human rights and the conduct of medical monitoring is critically reviewed. The conceptual framework behind the CCOHS guidelines omits to distinguish between medical evaluation for operational purposes and research or between personal information for a history record and that used for interpretation of possible health outcomes. Constraints on data collection will adversely affect worker protection and the identification of unsuspected occupational disorders. Knowledge is better than ignorance, and workers should not be deprived of the right to a safe workplace by the restriction of efforts to understand work conditions.

Key Words: human rights, medical monitoring

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Recently, in an editorial in the *American Journal of Industrial Medicine*, Dr. Gordon Atherley of the Canadian Centre for Occupational Health and Safety suggested that increased attention be paid to the potential conflict between individual human rights and the conduct of monitoring, surveillance and other medical evaluation programs that gather information on employees.[1] The thrust of his argument is that abuses have occurred and are likely to occur in the future and that a formal set of guidelines for the conduct of monitoring or evaluating medical programs is needed with some degree of urgency.

There is some risk involved in engaging in a critical examination of this position. The critic is open to charges of insensitivity, naïvete, manipulation by interested parties, or worse. Such a risk is worth assuming, however, if the discussion surrounding this issue is to be made more rigorous and socially useful. To date, the issue has been articulated from one point of view, without much depth of response in public or professional forums. The quality of discussion on this proposition has not been as thorough as the importance of the issue merits. The potential consequences of a poor decision are serious. It is, therefore, essential that the discussion become a genuine dialogue.

At the outset, it will simplify matters to describe the consensus that has emerged on several points among occupational health professionals following this issue. These points are not substantial areas of dispute:

1. The conduct of outcome monitoring and surveillance programs for working populations of interest is not an acceptable substitute for exposure monitoring and control.
2. Employers, health professionals and any other parties involved in monitoring or other health evaluation programs have a moral and ethical obligation, and, often, a legal duty, to see that the workers under evaluation understand the purpose, degree of validity and consequences of participation.
3. Workers have an absolute right to be informed of their individual results and the implications for their health and well-being; this information is confidential.
4. Employers have no right to information that does not

pertain directly to either occupationally-related disorders or the capability of a worker to perform the job assigned.

5. Unusual or special evaluation techniques, such as a biomedical monitoring procedure under development and not yet standardized, especially if invasive, should be conducted only with the specific consent of the worker.
6. Commitment to a monitoring or surveillance program implies that the data will be gathered for a purpose and that the findings will be acted upon.

Although these six points represent substantial areas of agreement among many occupational health professionals, labour representatives and employers, the remaining terrain is in dispute.

The proposed guidelines appear reasonable on the surface, but on closer examination they may cause serious damage to sound occupational health practice and particularly to research and the identification of previously unsuspected problems.

Background

Dr. Atherley's assertion that 'human rights legislation may well have to be invoked to protect individuals against harmful consequences of biomedical surveillance' is coupled in his editorial with the challenge 'Who will take the initiative in the U.S.A.?' and the assertion that 'something along these lines [written guidelines] has already been started by the staff of the Canadian Centre for Occupational Health and Safety.'[1] This implied claim of a definitive response to a newly recognized problem may come as a surprise to occupational health professionals and agencies that have grappled with these same issues for many years. The efforts undertaken by the Canadian Centre for Occupational Health and Safety are neither the first nor the most thorough in Canada or in North America. Other ethical guidelines and codes in respect of human rights have been prepared by the Canadian Medical Association,[2] the American Occupational Medical Association,[3] the American Medical Association,[4] the American Public Health Association (Occupational Health Section)[5] and the U.S. National Commission on Confidentiality of Medical Records.[6]

The treatment of this issue as a new problem in Canada may have surprised the American readers for whom it was intended. They may have concluded from Dr. Atherley's writings that the legal framework for the protection of human rights was lacking in Canada. Anticipating the legal implications of the *Charter of Rights and Freedoms*,

Canada has been engaged in a wide-ranging and constructive national debate over the human rights implicit in all areas of Canadian life. Dr. Atherley's remarks were presumably in this vein and do not appear to respond to any uniquely regressive policies of the past. The circumstances that led to recent debate over human rights in Canada are not well known in the United States because they are unique to the Canadian legal and political system. Indeed, Dr. Atherley himself concedes that '[t]he past 25 years have seen the growth in Canada of protection against discrimination . . . . This is beginning to have an effect on occupational health and safety.' Indeed, the conceptual basis of the proposed guidelines appears to be a projection of what might occur in the absence of any legal enforcement of Charter provisions or precedent of law, not on what might be expected in Canadian society today.

To justify the need for guidelines in this area of occupational health practice, Dr. Atherley has presented a series of incompletely described cases,[2,3] supplemented by anecdotes and newspaper clippings.[4] No evidence has yet been submitted to suggest the existence of a pattern of abuse that would be controlled by the introduction of a set of guidelines.

Critique of the Concept

The conceptual framework for the proposed guidelines has been developed by Dr. Atherley and his colleagues in one publication in the health services literature,[7] one presentation to a U.S. National Institute for Occupational Safety and Health (NIOSH) conference in 1984, a document distributed in Canada by the centre,[8] and four unpublished speeches before largely lay audiences[9-12], distributed by the centre as working papers. Few members of the occupational health professional community in Canada have had the opportunity to study the proposal carefully in a neutral forum.

The term 'medical monitoring' is used in five papers[7,9-12] and 'biomedical surveillance' in two[1,8], with essentially the same definition: 'any medical examination, including questionnaires, offered or required in connection with employment,' excluding those initiated by a worker seeking personal care from a private physician. The definition is so broad that it includes every conceivable medical encounter in occupational medicine save private visits, including episodic care for injuries since the injured part must be examined. The terms used do not conform to standard definitions, particularly when 'monitoring' and 'surveillance' are used interchangeably to cover most types of medical interactions.[13,14] As terms, 'medical

monitoring' and 'biomedical surveillance' are meaningless generalizations. There are many applications of medicine to evaluate the health of the worker; each has its own practical problems and its own legal and ethical framework. Lumping every medical activity into 'biomedical surveillance' obscures important distinctions and makes a confusing topic impossible. Table 1 presents seven very different medical evaluation functions falling under Dr. Atherley's definition of medical or biomedical monitoring or surveillance. It is a heterogenous list, with few ethical issues in common, other than confidentiality and consent.

Table 1 **Human Rights Issues Associated With the Application of Specific Medical Activities to Workers. Privacy and the Need for Consent Are Common to All.**

Medical Activity	Particular Problems
1. Preplacement evaluations	Test validity as predictor Access to personal health information Screening for susceptible states
2. Fitness for return to work	Consistency of criteria
3. Occupational health monitoring	Collection of personal health data
4. Occupational health surveillance	Labelling of high-risk groups Substitution for control
5. Case finding for occupational disorders	Data can be used by both sides in WC cases
6. Case finding for health risks	Inevitably encroaches on privacy, lifestyle 'Second chance' before serious consequences
7. Occupational health research	Communication of findings to subject Labelling of high-risk groups

The description of the conceptual framework behind the guidelines that follow is drawn directly from the published sources, except where noted.[7,8] Five crucial conclusions are presented.[7]

1. 'Medical monitoring . . . reaches into civil liberties

and human rights, often challenging them, and sometimes injuring them.'

2. . . . [A]ny proposal to incorporate medical monitoring into occupational health and safety legislation must be subjected to political decision making because the erosion of human rights is a political and ethical matter, not a technical one.
3. Medical monitoring should be the subject of explicit legislation by elected representatives, not rule-making by administrators or technical formulation by health professionals. Such legislation should specify 'what types of medical monitoring should be administered, who should be invited or required to be subject to the monitoring, and what the consequences should be of a refusal of a person to take a test, or an adverse result in the test.'
4. Health professionals and investigators should be prepared to explain medical monitoring procedures and demonstrate their validity. 'Lawyers sympathetic to the needs of ordinary people must attempt to understand the technicalities well enough to explore them for their effects on human rights.'
5. 'A minimum package of human rights protection is required for incorporation into all occupational health and safety legislation.

The first conclusion, that 'medical monitoring' reaches into civil liberties is true on the face of it, but is not unique to occupational health. Society presents many more situations in which rights between parties tend to conflict than it provides clear-cut examples of moral choices. That is why Anglo-Canadian jurisprudence is built on precedent and case law, and why legislation is usually considered an ultimate, rather than an initial, resort. In a modern technological society, rights are balanced against rights in most areas of human endeavour. One class of individual human rights is considered absolute: to equal protection under law, to decline to incriminate oneself, to security against arbitrary detention, and so forth. The remainder – and by far the greatest number – are relative (freedom of expression, to travel freely, to vote, to assemble peaceably, to conduct affairs in the language of one's heritage, and so forth). The balancing of relative rights is a social issue of great complexity. We are accustomed to accepting limits on those rights in numerous social interactions, such as testimony under subpoena against third parties, prohibition against slander and libel, military service and to protect the public safety. In particular, we accept a compromise on our privacy as part of an

implicit socially-determined contract whenever we provide information for entitlement programs (such as unemployment, welfare, general disability insurance), personal health or life insurance, financial credit and public health measures. Should medical evaluation in occupational health be subject to a unique code of guidelines discordant with other aspects of life? If so, to what purpose? Who will enforce it? If the code is not discordant, why is it needed? The treatment of medical evaluation as a separate issue reinforces the isolation of occupational health from the mainstream of medical practice and political activity, an isolation that has historically been to its detriment.

The second conclusion, that such activities should be subjected to the political process, seems to run counter to the logic of the first. While it is true that democracies should rest on the will of the people in matters of broad policy and philosophy, it does not necessarily follow that technical provisions of monitoring and medical evaluation lend themselves to the legislative process. Experience with language legislation in Canada suggests that the political mechanism is a poor one to deal consistently with technical issues having an emotional cast to them. Historically, human rights have been better protected by broad legislation and judicial interpretation of disputed claims. This is particularly likely to be the case on the provincial level.

Explicit legislation on matters of medical evaluation, the third conclusion, is particularly threatening, both to workers and employers. The prospect of legislated practice in medicine is inimical to most professionals and would also retard progress in developing new approaches or techniques, such as the introduction of biological exposure indices. It would remove medical evaluation from the collective bargaining agenda and freeze the occupational health care system into rigidity at a time of rapid change in technology and the economy. There is also no guarantee that a legislature enthused about its role as monitor of medical practice will stop with the particulars suggested.

The fourth conclusion, that health professionals explain and demonstrate the validity of the proposed evaluation is not in question, but it conveys an implication that when occupational health professionals do not do so, it is somehow not recognized as a violation of ethics and responsible practice. On the contrary, failure to do so is a clear breach and a major preoccupation of human subjects committees and medicolegal agencies. Violations of this basic tenet in practice are to be deplored, but there is nothing new in the assertion. Validation of evaluation

procedures in the first instance requires preliminary trials; it is an irresponsible position to deny the introduction of new or experimental tests on the grounds that they have not yet been validated when a trial is essential to their validation. Some may find the tone of this provision offensive. The criteria for establishing the validity of medical evaluation procedures have come from health professionals themselves, acting responsibly, not from individuals outside the biomedical sciences who have imposed it as a reluctant obligation. Medical activities in the workplace are undergoing profound change, and much of this change is due to new information generated by research and monitoring activities. The Task Force on Health Surveillance of Workers has provided a critical and thorough evaluation of common testing procedures.[15] Low back X-rays, routine chest films, genetic screening and the effectiveness of the annual physical have all been questioned only in the last 10 years by medical investigators themselves. The criteria for assessing the validity and usefulness of tests have emerged from rigorous epidemiologic research. A good example is the intensive effort to evaluate screening procedures for the early detection of lung cancer and the documented inadequacy of sputum cytology as a means of screening for resectable malignancies.[16,17]

The fifth conclusion, that a minimum rights component should be incorporated into all occupational health legislation, is questionable on the basis of precedent. American occupational health standards have incorporated a number of such provisions, both explicitly (as in the case of medical removal provisions) and implicitly, as part of the legislative or deliberative history. This had led to a highly inconsistent pattern of standard-specific measures and a degree of inequity based on whether a worker is exposed to noise, lead, acrylonitrile, chromates, cotton dust, or whatever.[18] The opposite approach, that of interpreting all occupational health legislation or mandated standards according to a uniform charter of rights and freedoms, would seem to promise greater equity and protection of human rights.

The conceptual framework behind Dr. Atherley's guidelines omits two exceedingly important distinctions. The first is the difference between medical evaluation procedures undertaken for operational purposes in occupational health practice and those undertaken for research. The second is the difference between information on personal information gathered as part of a dossier on individuals and that used in the interpretation of possible occupational health outcomes.

Research is particularly vulnerable to the adverse effects of a set of guidelines. When research is directed toward developing new indicators of injury, such as new tests of previously unsuspected disorders, it is usually not possible to demonstrate the validity of the technique applied. Furthermore, the proper evaluation of most suspected occupational disorders absolutely requires the availability of personal information not directly related to occupation, such as smoking habits.

The proposed code makes no mention of how compliance with the code would be monitored and enforced. It is logical to assume that it could become the basis of a review procedure (particularly for research application) or the collective bargaining agenda or of specific legislation. Incorporation of a code into collective bargaining agreements runs some risk of distortion into unwieldly or inadequate efforts, but would not be inappropriate for operational monitoring or surveillance programs if the code were well framed. Imposition of a review process or rigid legislated requirements is another matter, however, particularly as research may be constrained. Because of general concerns over ethics in research, proposals are already subjected to multiple review procedures, as required by institutional and funding agency guidelines. Further reviews many be required for collaborative studies or at the discretion of a funding agency. There is no surer way to stop or to slow occupational health research in Canada than by adding procedural obstacles.

The constraint on collection of personal data is also troublesome. The interpretation of health data for occupational purposes depends on identifying the occupational effect. Without data on personal exposures and lifestyle, particularly on smoking, alcohol use, noise exposure, hobbies and diet, and on personal and family medical history, how can one separate a genuine occupational health problem from a personal or community health problem? That such information is sensitive and must be kept strictly confidential is a given, but a system that precludes or renders impossible in practice the collection of such data under any circumstances is likely to be ineffective in protecting the health of the worker and in identifying previously unsuspected occupational disorders.

Critique of the Proposed Guidelines

The text of the proposed guidelines that follows is taken from the presentation by Dr. Atherley to the 1984 NIOSH meeting:[7]

In order to protect the health and dignity of Canadian workers, the following rights should be recognized in full:

1. **The right to know.** That is, the right to obtain trustworthy, comprehensive and understandable information about the risks of work and of the medical monitoring in connection with work. The worker should have the right to copies of test results, to a full explanation of the tests, to their interpretations and to knowledge of the uses to which the data will be put.
2 **The right to skilled medical advice in all aspects of the work-health relation.**
3. **The right not to be discriminated against** on the grounds of ill health or disability.
4. **The right to privacy**, specifically concerning confidentiality of medical information.
5. **The right to refuse medical monitoring** carried out in connection with work. That is, no medical monitoring is to be carried out without the worker's specific and informed consent.
6. **The right to procedural protection** and to full compensation if medical monitoring leads to loss of job or benefits.

'The worker should have the basic responsibility for deciding whether to accept a particular job. The essential limitations on the worker's freedom of choice are whether the worker can actually carry out the job and the degree of risk to others which acceptance of the job would entail. In order to determine whether a worker is capable of doing a particular job, a practical assessment rather than medical tests or questionnaires should be used.'

A second version of the guidelines was published in 1986.[19] It is very similar, except for the inclusion of a 'right to confidentiality' and a clarification that 'medical monitoring' is not intended to include 'case-finding where heavily exposed workers are sought out for special testing.' It should be noted that this definition is, in fact, commonly accepted as an operational definition of surveillance. The 1984 version is discussed here because it has been most widely disseminated. Both versions of the guidelines are exceedingly vague. Aside from the ambiguity inherent in the loose definition of 'medical monitoring,' several provisions show a degree of confusion in defining legal and ethical terms.

The 'right to know,' the 'right to confidentiality' (1986 version) and the 'right to skilled medical advice' are perhaps the least controversial parts of the guidelines. Since the introduction of the Worksite Hazardous Materials Information System, the 'right to skilled medical advice' is the only part not presently addressed under law or the *Charter of Rights and Freedoms*.[18,20] The right to know is

also part of informed consent and is also implied in the Charter's provision regarding 'security of the person' (section 7). The definition of 'skilled medical advice' is open, however. The selection of a medical adviser is not easy. At least to some degree, an element of confidence is needed in the professionalism of the physicians and nurses involved.[21] A sure road to biased and inadequate advice is to accept recommendations only from a small number of health professionals who consistently side with either labour or management.

The 'right not to be discriminated against' is also protected by the Charter (section 15) and by law in the U.S.[18] The problem here is one of determining what constitutes discrimination. Ashford, et al., in an exhaustive analysis of the general topic oriented toward U.S. law but useful conceptually within the Canadian system, demonstrated that in the U.S., employment practices bearing 'a manifest relation of the employment in question,' specifically, the safe and efficient operation of the business, is not discrimination. The use of monitoring information to remove workers from employment may be, however.[18] Thus, this provision of the guidelines clarifies nothing because it side-steps the definition of discrimination in this context.

The 'right to privacy' is a particularly thorny provision. Privacy in today's world is not the same thing as secrecy. If personal information could not be shared, there would be no financial credit, no law enforcement and no public health. Privacy today means that information is kept strictly confidential unless it is needed for a valid, socially-accepted purpose; that when information is used, the user absolutely cannot use that information for personal gain; and that when information is released, it is released in a form preventing the identification of any one individual. The emphasis should be on safeguards to ensure confidentiality and anonymity; secrecy will eventually cause progress in occupational health to grind to a halt.

The 'right to refuse medical monitoring' may have no legal basis in the U.S., where, under common law, employers can require compliance with reasonable programs of monitoring or surveillance as part of the terms of employment.[18] In Canada, a policy has yet to emerge, but no demonstrable trend of abuse has been reported. The general issue is that of informed consent. the centre's proposal explicitly requires 'specific and informed' consent, meaning not a right to refuse within the context of a general tacit agreement to participate, but a requirement for individual specific approval. In circumstances where the individual's person is involved or where information

is gathered that is not routine, each subject must, of course, give individual consent. However, when medical records are reviewed for a study or data are tabulated to search for a trend in health in the workplace, individual and specific consent for review of existing records is an insurmountable obstacle for practical reasons. If gathering each piece of datum required individual consent, occupational health in the real world of the workplace would stop cold. A system in which the worker may 'opt out' by taking a specific action will work; a system in which each worker must take a specific action to give approval will not.

The 'right to procedural protection' is the application of medical removal provisions. Due process and protection against arbitrary or hostile actions by management is, of course, accepted as essential to fair personal practices, and a body of law is developing on this topic.[18] The problem lies with the language 'if medical monitoring leads to loss of job or benefits.' Does this mean that if an employee is determined to be alcoholic, and this condition is confirmed on medical evaluation, that he or she is not to be dismissed despite repeated absenteeism, poor work performance and failure to accept treatment for the condition? Dr Atherley has accused critics of his writings as basing their criticisms largely on hypothetical or unrealistic cases.[10,12] In this provision, an important one, he has left the matter so vague as to apply to virtually any case in which a health problem leads to unemployment or reassignment.

Further Implications and Conclusions

The practical constraints that would follow the imposition of a series of guidelines as ambiguous as these are likely to be especially damaging to two institutions within occupational medicine: the workers' compensation system and occupational health research.

The legal framework of workers' compensation is based on a theory called the 'industrial contract,' in which workers and employers are presumed to engage in a special relationship within which there is a mutual concession of rights unique under the law. Workers concede the right to sue and employers concede the right to refuse to pay an adjudicated claim. Implied in this contract is the necessity of sharing information required to evaluate the claim fairly and to reduce the exposure to risk on both sides: the risk of exposure to hazard by the worker and to liability on the part of the employer. An interpretation of human rights that allowed one party to deny information to the other knocks the logical, if not legal, supports out from under the already deeply flawed workers' compensa-

tion system and throws us back to the much worse tort system. The right to decline medical evaluation could, by this logic, imply informed consent to accept the risks of a hazardous occupation, as it did under the old tort system. Since no association with work could then be proven or disproven, the employer and society would be denied information needed to ensure that the workplace was indeed safe.

It is important to separate occupational health research from activities intended to protect individual workers and to reduce the potential liability of employers, even though the same information could be used for both. Dr Atherley has written 'What is happening to science and knowledge and research today is a tragedy. . . . You can hire scientists to tell it any way you want it told.'[11] That abuses occur and that 'science is for sale'[11] on the part of a small fraction of occupational health professionals cannot be denied. Yet, it is surely an exaggeration to claim that, 'You have to ask the question, " Are any of them okay?" '[11]

Surely the corrective for the problem of professional disputes over research findings and for differences of opinion when the facts are not clear is not to restrict further the gathering of accurate information. The centre's mission includes the collection and dissemination of accurate scientific information. As a clearing-house for documentation and scientific analysis, the centre presumably appreciates the need for complete and authoritative data collection. Yet, Dr. Atherley has written '. . . workers should remember that North American medical research is a multi-billion dollar industry and that research workers are very effective lobbyists. . . . [I]t is unreasonable to expect them to be objective about the need for further research . . .'[10] This comment could be construed as an attempt to pre-empt rational discussion of research needs and priorities by discrediting the views of occupational health investigators. Such remarks are disheartening coming from the chief of the nation's primary repository for occupational health documentation. They appear to reflect a distrust of the scientific enterprise on which occupational health relies.

An Alternative

One might presume that occupational health problems could be identified effectively by primary care physicians in the absence of systematic surveillance and monitoring procedures. That is unlikely. Occupational injuries or illnesses are usually encountered sporadically in a typical primary care practice. The clinician can rarely obtain a

satisfactorily complete picture of the health experience of employees in a particular industry or plant. On the other hand, monitoring that covers a defined employee population can be used to follow the experience of the group. When the experience of a group of workers is followed over time, not infrequently, patterns of illness appear that suggest either unusual characteristics of that working population or exposure requiring control.

An alternative strategy to that proposed by the centre is one in which organized labour and responsible provincial government agencies protect the interest of the worker on an institutional basis by co-sponsoring, supporting or monitoring the integrity of data-gathering activities with built-in safeguards. This is the approach that has been pioneered in Canada by the Energy and Chemical Workers Union. Such a strategy would incorporate the points of concensus outlined at the beginning of this discussion but would not presume to impose an arbitrary, quasilegal framework. It would accept the common wisdom already in place: Data should always be gathered for a purpose, and abnormal findings should be acted upon, not filed. Commitment to a monitoring or to a surveillance program, especially, should be a commitment to action to control workplace exposure.

In the long run, knowledge is better than ignorance. The absence of facts is a poor way to protect anybody, even against themselves. In protecting the rights of workers, we should not be in a hurry to deprive them of the right to a safe workplace by unnecessarily restricting our efforts to understand the conditions under which they work.

Appendix

Types of Medical Evaluations Undertaken in Occupational Health

1. Preplacement evaluations. In scientific terms, preplacement evaluations are single-point screening studies performed to ensure that the worker's capabilities match the work to be done and that the worker is not extremely susceptible to harm from the work and is not likely to pose a threat to others by an inability to work safely. Human rights problems associated with preplacement evaluations are primarily associated with the validity of the test as an accurate predictor of work and safety performance and the access of an employer to information on an employee's personal health. A unique issue for preplacement evaluations is whether an employer is entitled to information on an employee's past work history in order to protect the employer against

unjustified workers' compensation claims. Genetic screening is a special case of preplacement evaluation with a very high potential for abuse of human rights and a biological basis so complicated that simple interpretation is not possible.

2. Fitness for return to work. These evaluations are similar to preplacement evaluations except that they pertain to a worker's ability to carry on following an injury or illness rather than to begin work. The unique problem here is whether a worker who is returning to a job should be held to the same criteria as a new worker or whether the experience of having held the job before makes the worker more capable than would otherwise be the case.
3. Occupational health monitoring. In scientific terms, monitoring is when one looks for health problems of many types that may or may not be related to workplace exposure. It is a way of detecting new occupational disorders and identifying previously unsuspected risk factors. Here, the problem is that information will be collected that has little to do with workplace hazards since these are not known beforehand. Labelling is not a problem since the worker group is not assumed to be at risk for some specific outcome.
4. Occupational health surveillance. Surveillance is very different from monitoring because one is looking for a specific health outcome that is known in advance. The purpose of surveillance is to determine whether a problem continues to exist despite measures to control it. The potential for labelling exists if workers are led to believe that because of their exposure to a hazard their health is very likely to suffer as a consequence.
5. Case finding for occupational disorders. When a suspected occupational disorder is identified, one documents the case as thoroughly as possible. This information will be used by both sides in a worker's compensation case and, in this sense, can be used 'against' a worker's interest in the narrowest definition of that interest.
6. Case finding for health *risks*. When a worker is found to be abusing alcohol, this information is as sensitive as any in occupational medicine practice and must always compromise the privacy of that individual in the personal sense. Yet, it would be difficult to defend the position that the worker should not be offered a chance to participate in an employee assistance program and to improve job performance before being fired because to do so would compromise the worker's privacy.
7. Occupational health research: Here the issues are

complicated by the fact that, while the specific findings of a study may not benefit each participating worker directly, all workers benefit by the application of occupational health research, especially in their own industry. Asbestos, vinyl chloride and benzene would never have been confirmed to be occupational hazards without research. Occupational health research typically takes place in settings where elaborate institutional safeguards are already in place, but is usually performed by investigators who are not under the control of either labour or management.

Each type of medical evaluation has a different profile of ethical issues; to put a general label of 'biomedical surveillance' on all of them and to treat them in the same way makes no sense. There are only two major ethical issues that the seven have in common: privacy and consent.

Résumé

On présente une analyse de la philosophie du Dr Atherley en ce qui concerne les possibilités de conflit entre les droits de la personne et la conduite d'examens médicaux périodiques. Le cadre conceptuel qui sous-tend les lignes directrices du CCHST ne fait pas de distinctions entre l'examen médical mené à des fins opérationnelles et celui effectué pour la recherche, ou entre les renseignements obtenus pour établir un dossier personnel et ceux qu'on utilise pour faire des pronostics sur des états de santé éventuels. L'imposition de contraintes sur la collecte des données aurait un effet défavorable sur le degré de protection des travailleurs et rendrait moins probable la découverte de maladies professionnelles jusque-là insoupçonnées. La connaissance est supérieure à l'ignorance; les travailleurs ne devraient donc pas être privés du droit à la sécurité au travail en raison de restrictions imposées sur les travaux visant à mieux comprendre les conditions de travail.

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Arsenic Exposure and Absorption in Underground Miners in an Ontario Gold Mine

Summary

A recent study of mortality in Ontario underground miners reported that the incidence of lung cancer in gold miners never employed in a uranium mine was significantly greater than in nickel miners or the general Ontario male population. A weak association was shown between lung cancer risk in gold miners and exposure to high levels of dust containing high levels of arsenic.

This project was designed to determine to what extent underground workers in gold mines are exposed currently to arsenic and if the arsenic is bioavailable.

The results indicate that the underground workers are exposed to arsenic and that the arsenic is at least partially bioavailable.

Key Words: gold miners, arsenic bioavailability

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Background

A number of epidemiological studies of smelter workers and workers engaged in the production and use of pesticides have shown an association between exposure to inorganic arsenic compounds and an increased risk of lung cancer.[1-3] It is commonly stated that the predominant arsenic compound in the atmosphere of a copper smelter is arsenic trioxide,[4] although other metals and other compounds such as arsenic sulphide[5] and sulphur dioxide have also been found. Although exposure to a number of trivalent and pentavalent inorganic arsenic compounds were reported in these studies, it is not possible, however, from the epidemiological data to relate the carcinogenicity to a specific compound or to a single valence state of arsenic.[6] In Ontario gold mines, arsenic is present in the ore in the form of arsenopyrite, FeAsS, an orthorhombic crystalline mineral.

A recent study of mortality in underground miners in Ontario[7] reported that the incidence of lung cancer in Ontario gold miners was significantly greater than among underground nickel miners and the general population of Ontario males. The authors of the mortality study suggested that the observed increase in mortality from lung cancer could be the result of exposure to arsenic in the underground environment.

Objectives

1. To determine the level of exposure to airborne arsenic of a group of underground gold miners in Ontario.
2. To determine if the arsenic derived from arsenopyrite in the ore, to which gold miners are exposed, is respirable and bioavailable. For the purpose of this study, bioavailable means that arsenic is absorbed from the working environment, as shown by an increase in the excretion of arsenic in the urine of miners following a period of work underground, and respirable means that absorption occurs through the lung.

Materials and Methods

An operating mine in north-western Ontario, where the ore body has a higher than average content of arsenopyrite, was chosen for this study.

The study was carried out as two related projects:

1. Personal air monitoring of underground miners to measure arsenic in total airborne dust during each eight-hour shift in the course of the work-week.
2. The collection of urine samples from the underground workers and a control population to be analysed for total arsenic content.

In addition, the arsenic content of samples of ore taken from drill cuttings and the airborne arsenic concentrations in total airborne dust were compared, and the stability of arsenic in urine samples, which were stored for up to 102 days, was investigated.

There were three groups of men in this study.

Group 1 was made up of 10 underground workers who were expected to have the highest exposure to arsenic in dust from the ore body. Personal air sampling devices were given to each of these men for five consecutive eight-hour working days. Urine samples were collected from these miners on the first and last days of the work-week. The work-week was five days long for eight of the underground workers and four days long for two of the underground workers. All of the miners in Group 1 had been employed steadily in the same environment for more than three months, and all had been working underground the week prior to the study.

Group 2 consisted of 46 underground workers employed in the same mine who were exposed to dust containing arsenopyrite. These miners had personal air sampling carried out for one day during the same work-week as Group 1. This sampling was carried out to extend the number of measurements of arsenic exposure of the underground workers and to determine if the exposure of Group 1 was as great or greater than other workers during the week the survey was carried out. Urine samples were not collected from the workers in Group 2.

Group 3 was a control group of 10 men with no occupational exposure to arsenic. These men lived and worked in the same geographic area as the workers in Groups 1 and 2. One urine sample was collected from each of these men. These urine samples were taken several months after the samples were collected from the underground workers.

Air sampling was carried out by the Mining Health and

Safety Branch of the Ontario Ministry of Labour. Gravimetric samples were collected, using Dupont P4000, Dupont Alpha I and Gillan sampling pumps. Untreated 37 mm 0.8 micron pore size cellulose ester filters (Gelman Type GN-4) were used. The flow rate was two litres per minute.

Arsenic was measured in the Occupational Health Laboratory of the Ontario Ministry of Labour. All the reagents were ACS reagent grade or better, and low in arsenic. Distilled, deionized water was used throughout the experiment. A stock solution (13,350 μmol/L) of arsenic (V) was prepared by dissolving 0.7671 g of arsenic pentoxide in 15 mL of 20 per cent w/v potassium hydroxide solution, neutralizing with 20 per cent v/v sulphuric acid and diluting to 500 mL with 1 per cent v/v sulphuric acid. Sodium tetrahydridoborate was prepared daily by dissolving 10 g of sodium tetrahydridoborate in a sodium hydroxide solution (1 per cent w/v), diluting to 500 mL with the same solution and filtering through a Whatman #2 filter paper.

The atomic absorption spectrophotometer was a Perkin-Elmer 703 equipped with an electrodeless discharge lamp, a Perkin-Elmer MHS-20 automated hydride generator and an electrically heated quartz absorption cell.

A measured quantity of the urine sample was digested with a mixture of concentrated nitric, sulphuric and perchloric acids to destroy the organic matter and convert the various species of organo arsenic compounds present in the urine into an inorganic pentavalent arsenic salt. The digest was then heated to remove all traces of nitric and perchloric acids, and a suitable portion of the digest was transferred to a reaction flask of the hydride generator where the pentavalent arsenic in the digest was reduced to the trivalent form by the addition of acidic potassium iodide solution.

Alkaline sodium hydridoborate was then added to generate arsine, which was swept into the heated (900°C) quartz cell of the atomic absorption spectrophotometer where it was decomposed and the absorption of the resultant atomic arsenic species was measured at 193.7 nm.

The amount of arsenic in the samples was determined by comparing the sample absorbance with a calibration curve generated from arsenic (V) standards treated in a manner similar to that of the sample digests.

The stability of arsenic in urine over an extended period of time and for specified storage conditions was investigated. The samples were collected in standard plastic, screw cap bottles, and approximately 0.3 mL of glacial acetic acid was added for each 50 mL of urine collected.

The samples were then stored in a refrigerator at 4°C and analysed a number of times over a period of 102 days.

Fifteen samples of drill cuttings were collected in some of the workplaces where airborne dust samples were being taken in order to compare the arsenic concentrations in the ore and in the air.

All arsenic concentrations in urine are reported in this study as μmol of arsenic per mol of creatinine. The adjustment of arsenic in urine to urinary creatinine is a correction parameter for biological indicators measured on spot urine samples as opposed to 24-hour urine samples. This method is frequently used and is based on the assumption that the amount of creatinine excreted per day is relatively constant.

A brief questionnaire to determine age, smoking and dietary habits and occupational history was prepared for the workers in Group 1. This questionnaire was self-administered under supervision.

For the purposes of statistical analysis, concentrations were assumed to belong to a log-normal distribution. The appropriate statistics that describe the log-normal distribution are called the geometric mean and the geometric standard deviation. The geometric mean represents the median value of the log-normal distribution and the geometric standard deviation gives a measure of the variability of a set of numbers.

The difference in urine levels between the beginning and the end of the week for workers in Group 1 was tested using a paired-difference t-test, and the differences between other groups were tested using unpaired t-tests. One-sided p-values were reported when testing hypotheses.

Results

The results of the investigation of the stability of arsenic in urine samples stored for up to 102 days are shown in Table 1. There was a mean increase of five per cent (range −7 per cent to 11 per cent) in the amount of arsenic measured after 102 days of storage as compared to fresh samples for the 12 test samples of urine.

At the beginning of the work-week, the total arsenic levels in the urine of the workers in Group 1 were reported to range from 13.4 to 32.9 μmol/mol creatinine. The geometric mean was 23.5 μmol As/mol creatinine and the geometric standard deviation was 1.46. Nine urine samples were obtained at the end of the work-week from Group 1. These urine arsenic levels ranged from 13.8 to 57.9 μmol/mol creatinine. The geometric mean was 25.9 μmol As/mol creatinine and the geometric standard deviation was 1.63.

Table 1 **Investigation of Stability of Arsenic in Urine**

Sample Number	Concentration (μmol As / L urine) Initial Value	Time in Storage (days) 7	14	60	102
U-100	1.54	1.50	1.56	1.53	1.68
U-200	0.27	0.28	0.28	0.27	0.30
U-300	0.28	0.26	0.26	0.25	0.26
U-400	0.82	0.76	0.80	0.73	0.79
U-500	0.22	0.22	0.24	0.23	0.23
U-600	0.26	0.26	0.28	0.27	0.27
U-700	0.76	0.82	0.86	0.80	0.85
U-800	0.45	0.46	0.48	0.44	0.49
U-900	0.23	0.25	0.25	0.26	0.25
U-1000	0.35	0.38	0.35	0.36	0.36
U-1100	0.70	0.69	0.71	0.71	0.73
U-1200	0.33	0.32	0.34	0.33	0.34

Air sampling results for Group 1 ranged from 0.1 to 36.0 μg arsenic per cubic metre of air with a geometric mean exposure of 3.4 μg As/m^3 air. See Table 2 for these results. The amount of airborne arsenic on the first day of work appeared to be greater than on subsequent days.

The amount of arsenic in the drill cuttings ranged from 0.02 per cent to 0.86 per cent. See Table 2 for these results. Figure 1 shows the relationship between the mean amount of airborne arsenic during the last four days of the work-week and the mean arsenic content of the ore: The meas-

Figure 1 **Comparison of Airborne Arsenic and Arsenic in Ore**

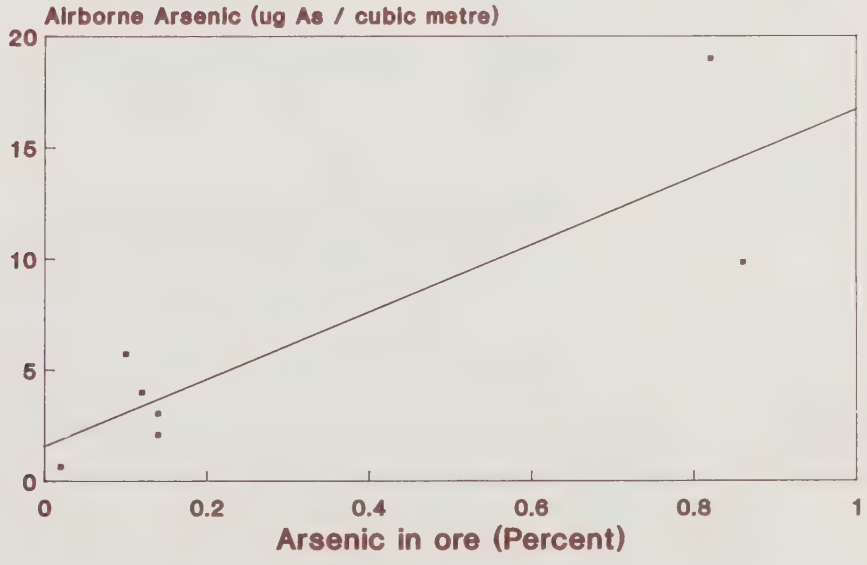

Table 2 **Amount of Arsenic in Air, Urine and Ore**

Group 1

Identity Number	Urine		Air					Ore
	First Day	Last Day	Day 1	Day 2	Day 3	Day 4	Day 5	(%)
1	29.0	*	3.0	21.0	10.3	5.4	2.6	0.86
2	31.7	57.9	31.0	14.0	10.0	31.0	21.0	0.82
3	32.9	39.4	34.0	1.5	0.7	7.7	13.0	0.10
4	13.4	15.9	*	1.4	8.8	1.3	0.7	0.14
5	29.1	29.1	1.4	1.1	0.9	0.5	0.1	0.02
6	29.2	26.0	8.3	2.5	7.4	2.1	16.0	*
7	14.5	14.1	1.6	0.9	2.3	0.4	*	*
8	31.4	32.9	2.4	14.0	*	4.3	3.8	*
9	13.5	13.8	1.1	3.0	1.4	2.0	2.0	0.14
10	24.6	30.0	36.0	10.0	1.4	0.9	3.7	0.12
Geometric Mean	23.5	25.9	5.6	3.8	3.0	2.4	3.0	0.16
Geometric Standard Deviation	1.46	1.63	4.30	3.32	3.02	3.79	5.39	3.67

Group 3

Identity Number	Arsenic in urine
c1	8.0
c2	11.7
c3	37.7
c4	11.3
c5	13.8
c6	16.0
c7	14.7
c8	14.1
c9	9.7
c10	761.9
Geometric Mean	13.8
Geometric Standard Deviation	1.55

Notes: 1. Arsenic in urine is reported as μmol arsenic/mol creatinine, arsenic in air is reported as μg arsenic/m^3 air and arsenic in ore is percent arsenic weight/weight.
2. Missing values are indicated by *
3. Day 1 for air measurements is June 23, 1986 and Day 5 is June 27, 1986.
4. The geometric mean and standard deviation for Group 3 was calculated using the data from men labelled c1 to c9.

urements of airborne arsenic taken on the first day of the work-week were not used in this calculation as they appeared to be different from those measured on other days of the work-week. The data indicate a statistically significant increase in the amount of airborne arsenic as the amount of arsenic in the ore increases ($p = 0.006$).

The values reported for the 46 workers in Group 2 ranged from 0.1 to 23.0 μg As/m³ air, the geometric mean was 2.2 μg As/m³ air and the geometric standard deviation was 2.87. The amounts of arsenic in total airborne dust in raises and developments, in stopes and on trams could not be shown to be different. However, the number of samples in each area was small and the variation in the measurements was large. See Table 3 for the geometric mean, the geometric standard deviation and the number of samples in each area.

The urine arsenic levels of Group 3 ranged from 8.0 to 761.9 μmol/mol creatinine. The value from the worker in Group 3 with a urine arsenic level of 761.9 μmol/mol was an outlier because of a dietary intake of arsenic and was not included in further calculations. The geometric mean of the urine arsenic of the nine workers in Group 3 was 13.8 μmol/mol and the geometric standard deviation was 1.55. See Table 2 for these results.

The difference between the median urine arsenic levels of Group 1 at the beginning of the work-week and Group 3 was statistically significant ($p = 0.01$). The difference between the median urine arsenic levels of Group 1 at the end of the work-week and Group 3 was also statistically significant ($p = 0.006$).

The calculated median percentage increase in the level of arsenic in urine of the exposed workers (Group 1)

Table 3

Amount of airborne arsenic in total airborne dust in workers employed in various parts of the mine

Area	Number of Measurements	Geometric Mean	Geometric Standard Deviation
Raises & Developments	7	2.1	2.15
Stopes	23	2.2	3.44
Trams	11	3.3	2.25
Miscellaneous	5	0.96	1.70
Total	46	2.2	2.87

Note:
Arsenic in air is reported as μg arsenic/m³ air.

between the beginning and the end of the work-week was 13 per cent, with 95 per cent confidence limits −4 per cent and +34 per cent. The change in the amount of arsenic in the urine of Case Number 2 was much larger than for any of the other underground workers. It is noteworthy that among the men in Group 1, this man also had the greatest measured exposure to arsenic in air.

Summary

1. The results of this study confirmed the selection made by the mine hygienist who selected the men in Group 1 as having the highest exposure to total airborne arsenic.
2. The median urine arsenic values of underground workers who worked in high underground dust concentrations, Group 1, is higher than those of the men who did not work underground and who lived in the same area as the underground workers, Group 3.
3. The median urine arsenic values of underground workers who worked in high dust concentrations are higher at the end of the work-week than at the beginning of the work-week.

Discussion

The results of the investigation of the stability of arsenic in urine suggests that arsenic in urine specimens may be stored for at least three months if kept in the dark at 4°C and preserved with a small quantity of glacial acetic acid.

In this survey, there were eight underground workers for whom both urine and air arsenic measurements were made. The underground workers examined in this study appear to have an exposure to arsenic, which the control group does not. In spite of this small sample, there does appear to be an association between the amount of arsenic in the air to which the underground workers are exposed and the amount of arsenic in their urine. The increase in urine arsenic during the work-week among the underground workers further supports the conclusion that the source of the arsenic exposure was the underground work environment.

Urinary arsenic values were measured in 1981 in a cross-sectional health survey of copper smelter workers, underground gold and copper ore miners and retired employees of a Quebec company[8] (Lilis et al., 1982). The laboratory techniques used in the Quebec study and in this study were not the same, but give comparable results. The Quebec survey showed that the 143 employees who were employed as underground workers had a mean

urinary arsenic value of 14.2 (95 per cent confidence interval 12.0, 16.4) μg/g creatinine or 21.4 μmol As/mol creatinine. The 680 copper smelter workers in the Quebec study were reported to have a mean urinary arsenic value of 21.7 (95 per cent confidence interval 20.1, 23.3) μg/g creatinine or 32.8 μmol As/mol creatinine. In comparison, the members of Group 1 in this study had a geometric mean value of 23.5 μmol As/mol creatine and the members of Group 3, the unexposed controls, had a geometric mean value of 13.8 μmol As/mol creatinine. The Quebec study did not report the levels of arsenic in air, either underground or in the smelter environment. Although a small number of underground Ontario gold miners were considered, the measured amounts of arsenic in urine are comparable to those reported in the 143 underground copper ore miners in the Quebec study. It is reasonable to assume that exposure to arsenic of this magnitude may exist in other underground environments.

In a case-control study of 119 lung cancer cases in Ontario gold miners, a weak association was found between lung cancer risk and exposure to high levels of dust in gold mines where the arsenopyrite content of the ore was higher than in other gold mines in Ontario.[7] No historical measurements of arsenic in the urine of Ontario gold miners have been found for the mine considered in this study. The data presented in this study represent current exposure to airborne arsenic and may not be representative of past exposures in Ontario gold mines. The data presented here are not yet sufficient to support a causal relationship between exposure to arsenic in the underground environment of Ontario gold mines and the risk of lung cancer.

Conclusion

This survey demonstrates that the underground workers in this gold mine were exposed to arsenic in the work environment and that this arsenic was at least partially bioavailable.

Résumé

D'après une étude récente sur les causes de mortalité chez les mineurs de fond de l'Ontario, l'incidence de cancers pulmonaires chez les travailleurs des mines d'or qui n'ont jamais été employés dans une mine d'uranium est considérablement plus élevée que chez les travailleurs des mines de nickel ou chez la population masculine ontarienne en général. On a démontré une faible association entre le risque de cancer pulmonaire chez les travailleurs des mines d'or et l'exposition à des quantités élevées de poussière contenant une forte proportion d'arsenic.

Ce projet avait pour objet d'évaluer dans quelle mesure

les mineurs de fond dans les mines d'or étaient exposés à l'arsenic et de déterminer si cette substance était 'biodisponible.'

Les résultats indiquent que les mineurs de fond sont exposés à l'arsenic et que ce dernier est au moins partiellement 'biodisponible.'

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Alternative Method for BSF-TPM Determination in Airborne Coke Oven Emissions

Summary

A streamlined, high thoroughput and accurate method for determining BSFTPM (Benzene Soluble Fraction of Total Particulate Matter) in airborne coke oven emissions is described. The OSHA and NIOSH methods as well as the method described under the Ontario Ministry of Labour Code, have, in view of the very low TLV (0.15 mg per metre cube), analytical limitations with regard to accuracy and precision. This paper is an attempt to address the limitations and present a viable alternative method that is both accurate and precise as well as rapid with high thoroughput. The method developed has been in routine use at Stelco for the last four years.

Key Words: coke oven emissions, BSFTPM measurement

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Regulations under the Ontario *Occupational Health and Safety Act*, Chapter 321, Designated Substance – Coke Oven Emissions – regulates the benzene soluble fraction of total particulate matter (BSFTPM) of the substances emitted into the atmosphere from metallurgical coke ovens, including condensed vapour and solid particulate. Both OSHA and NIOSH have been involved in developing a standard method for the measurement of airborne coal tar pitch volatiles (CTPV). In the early 1970s a Soxhlet extraction method was in use to determine CTPV, collected on a pre-weighed combination filter composed of fibreglass and silver membrane filters. After re-weighing etc., the filters were clamped in the holding device of a copper thimble and placed in the Soxhlet extractor. The CTPV was extracted with benzene for six hours. Finally, after draining the solvent, the filters were removed from the thimble, dried and re-weighed. The difference in the filter's weight was used to calculate the CTPV, now designated BSFTPM. This procedure yielded high and variable blanks owing to the loosening and removal of fibres from the filters. During the extraction of CTPV (BSFTPM), there was also the probability of some particulate matter to loosen and be removed from the filter. This would also result in inaccurate BSFTPM values. The method was cumbersome and slow, requiring a lot of fume hood space for the Soxhlet apparatus set-up, limiting the number of determinations.

An alternative to the Soxhlet extraction method was published by OSHA.[1] In this procedure the BSFTPM from a glass and silver membrane combination filter is extracted ultrasonically by benzene. The extract and rinses are filtered through a fritted glass funnel into a 10 mL Knotes graduated evaporative concentrator. After evaporating down to 1 mL, a 0.5 mL aliquot (very small volume) is pipetted into a pre-weighed teflon cup and evaporated to dryness in a vacuum oven at 48°C for three hours. The teflon cup is re-weighed, and the weight gain is calculated to determine BSFTPM. This method is also cumbersome and slow, particularly the filtration through the fritted glass funnel, which requires drastic cleaning with chromic-sulphuric acid etc. for subsequent use. The method was

subject to errors, i.e.: high and variable blanks, and the loss of particulates resulting in inaccurate BSFTPM values. The NIOSH method,[2,3] issued in 1985, is similar to the OSHA method and subject to the same inherent errors, particularly errors due to cleaning procedures and the repeated handling of a small volume.

In June 1982 the Ontario Ministry of Labour, Occupational Health and Safety Division, issued a code[4] for measuring coke oven emissions as airborne benzene soluble compounds (BSFTPM). The extraction of BSFTPM, including filtration thereof, is similar to the OSHA/NIOSH methods along with the associated problems. However, the entire benzene extract, including washings, are collected into a pre-weighed porcelain crucible of 15 mL capacity and weighing approximately eight grams. This relatively high initial weight precludes the use of certain micro electronic balances, e.g., Mettler ME 22 with a maximum capacity of three grams and a precision of two micrograms. Furthermore, the use of an Allihn tube for filtering the extract using nitrogen pressure was found to be tedious. This was further complicated by the necessity of cleaning the tarry residue from the Allihn tube (for reuse) with chromic-sulphuric acid as indicated earlier. The extract is evaporated on a hotplate just to dryness after filtration into the procelain crucible, and further dried in an oven at 100°C for two hours, compared to drying in a vacuum oven at 40°C as specified in the NIOSH method. It is quite conceivable that the temperature of drying may effect the BSFTPM content. In view of the large number of samples submitted for BSFTPM determination, as well as the problems described with the OSHA, NIOSH and the 'Ontario Code' methods, an alternative method was developed and is described in detail for completeness and clarity.

Experimental Determination of BSFTPM by Ultrasonic Extraction

1. General

Airborne TPM (total particulate matter) is collected on two glass pre-extracted filters. The BSFTPM is extracted ultrasonically, filtered, evaporated to dryness at 60°C and determined gravimetrically.

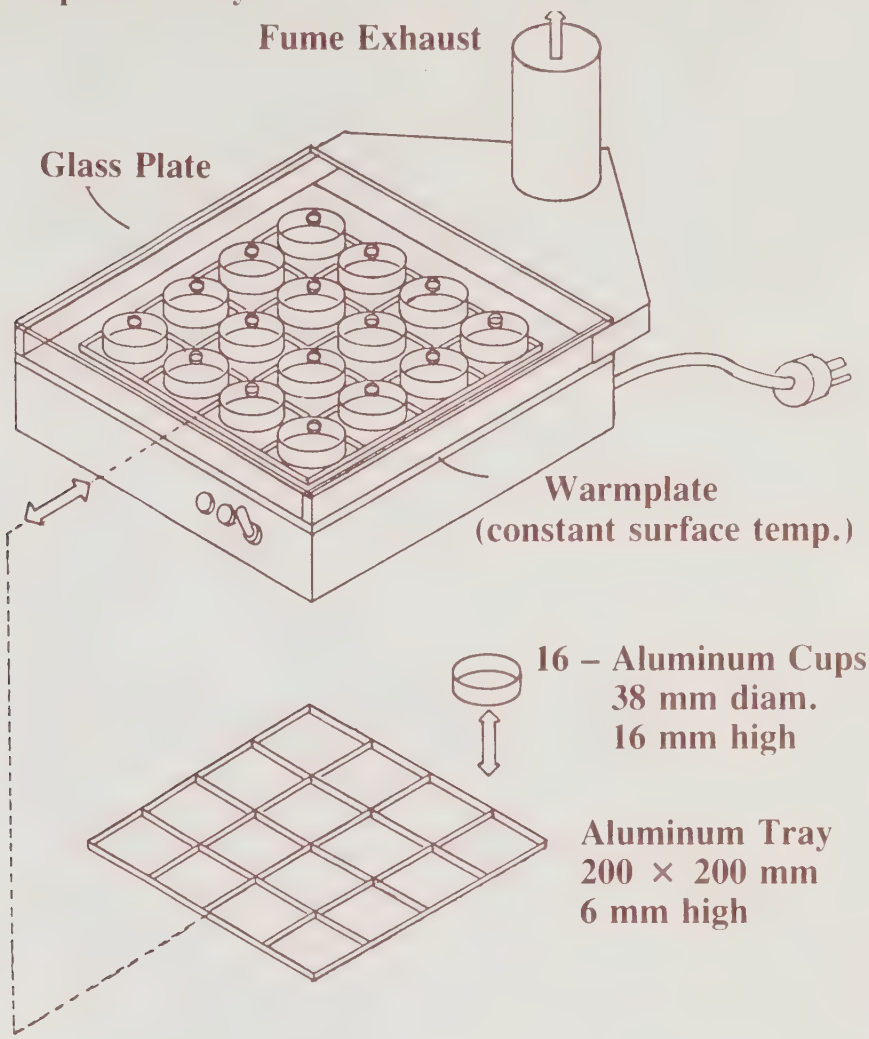
2. Range

For TPM and BSFTPM the lower limit is 0.01 mg using the Mettler 22 electronic microbalance with a detection limit of 0.001 mg weight

3. Apparatus and Reagents

The listed apparatus has been found suitable. Equivalent alternative apparatus can be used. Some of the equipment was custom-made in Stelco. (See Figure 1).

Figure 1 **Constant Surface Temperature Warmplate, Aluminum Cups and Tray**



a) Gelman type A/E 37 mm glass fibre filter (61652).
b) Millipore styrene plastic filter cassette (MO 0037 PO).
c) Millipore AP 10-MF support pad (AP 100 3700).
d) Millipore Millex SR 0.5 μm filter unit (SLSR 025 NS or SLSR 025 NB).
e) Becton-Dickinson Multifit Interchangeable Syringe with Luerlok tip, 10 mL (2152).
f) Electronic Microbalance: Mettler ME 22 (capability of determining a weight change of 0.001 mg).
   i) Calibration weights (Class S or equivalent for calibrating balance).
g) ME – shockless 5-point static bar static charge eliminator, (Simco Co. Inc., 920 Walnut St. Lansdale P.A. 19446).
h) Ultrasonic bath: (Bronson Instruments, model 0-50).
i) Centrifuge tubes, conical, heavy duty (17 × 135 mm) with pennyhead glass stopper (Corning 8124); test tube stand.
j) Aluminum cups (35 mm dia. × 20 mm height, 15 mL capacity)

k) Aluminum tray – 185 × 185 mm, (8.064 gauge) with 44 × 44 mm divisions for aluminum cup storage.
l) Uniform surface temperature – warmplate themostatically controlled (60° C), with plate glass cover with fixed location filter unit openings and a vapour extraction device. (Figure 1).
m) Electric Oven.
n) Heat gun – (Master Appliance model HG 301).
o) Universal Repipet Dispenser (Labindustries Canlab P 4973-5).
p) Benzene, high purity (BDH-Omnisolv).
q) Soxhlet extraction apparatus with Allihn condenser and flask.

4. Conditioning and General Treatment of Apparatus

a) Glass Fibre Filters – Prior to use, extract the glass fibre filters with benzene for four hours in a Soxhlet apparatus. Dry the filters in an electric oven in a fume hood at 50°C. Store in a glass-stoppered weighing bottle.
b) Aluminum Cups – The aluminum cups are soaked in benzene overnight, rinsed with fresh benzene, dried with a heat gun then heated on a warmplate at 60°C for one hour. The cups are desiccated overnight. Without using the static charge eliminator, weigh the cup (see 4(c) calibration) on the electronic microbalance and record weight 'X' mg to the nearest 0.001 mg. Return to the desiccator until required.
c) *Calibration*
The Mettler 22 electronic microbalance is calibrated every day using a Type S metric standard set as follows.
   i) Zero is set by adjusting the panbreak setting, and the setting recorded.
   ii) 50 mg, 200 mg, 200 and 50 mg, 500 mg, and 500 + 1,000 mg weights are used, and their weights, read to 0.001 mg, are recorded in a daily log book.
   iii) The internal 10 mg 'C' weight is recorded.
   iv) If necessary, the calibration set screws adjusted so that the final zero is 0.000, and the final 'C' is 10,000 mg. Long-time precision is demonstrated in Table 1.

5. Preparation of Filters for Sampling

a) Weigh, on the electronic microbalance, after passing over the static eliminator, two 37 mm pre-extracted glass fibre filters (3(a)) as a unit. Record weight 'A' mg to the nearest 0.001 mg. Place the two glass fibre filters in a filter cassette containing a support pad (3(c)). Place the identity on the filter cassette. Assemble the

Table 1 **Precision of Weighing on ME22**

Std. wts.	n	
50 mg	249	1.5 μg
200 mg	203	2.2 μg
200 + 50 mg	203	1.9 μg
500 mg	203	2.5 μg
500 + 1000 mg	226	2.6 μg

filter cassette, press tightly, seal with masking tape or shrink bands and insert plugs in each end.
Note: For field sampling, the following blank filters are required.

Number of Survey Samples	*Number of Blanks*
1 – 29	3
30 – 58	6
59 – 87	9

6. Sampling
Following the Ontario MOL Code of Practice or equivalent sampling procedure, sample approximately 0.7 metre cube of air volume (approximately six hours at 2 L/min

7. Determination of TPM
a) On receiving the filters after sampling, disassemble the filter cassette. Weight the two glass fibre filters as a unit after passing over the static eliminator. Record weight 'B' mg. The difference (B – A) is the TPM in mg in the sampled air volume.

This step, however, is not required in the BSFTPM determination, and some time can be saved by eliminating it. The TPM value is obtained in this laboratory only at the request of the Industrial Hygiene Department.

8. Determination of BSFTPM
a) Fold the two glass fibre filters and place inside a centrifuge tube (3(i)). Add 5 mL of benzene (3(p)) using a Repipet dispenser (3(o)) and replace the stopper on the centrifuge tube. Place the tube in the stand in ultrasonic bath, with the water level just above the benzene level. Sonicate for 10 min. The contents can be left standing overnight.
b) Secure a Millex SR filter unit (3(d)) to a 10 mL syringe (3(e)) and flush the unit with 5 mL benzene (3(p)). Transfer the contents of the centrifuge tube (filters plus benzene) into the syringe. Gently force the liquid through the filtration unit, collecting the filtrate in a pre-weighed aluminum cup placed on the aluminum tray (3(k)) positioned on the warmplate. Rinse the centri-

fuge tube once with 5 mL benzene (3(p)) and filter through the Millex SR filtration unit, collecting rinsings in the aluminum cup. Evaporate the filtrate to dryness on the warmplate with a uniform surface temperature of 60°C. Leave on the warmplate for one hour after the extract has evaporated. Cool in a desiccator overnight.

c) Without using the static charge eliminator, weigh the cup and contents on the electronic microbalance and record weight 'Y' (mg) to the nearest 0.001 mg. The difference in weight (Y – X) gives the weight of BSFTPM in mg in the sampled air volume.

9. Calculations

a) TPM (mg/metre cube) = (B – A)/V
where: (B – A) = weight of TPM in mg (16(a))
V = volume of air sampled in metre cube.

b) BSFTPM (mg/metre cube) = ((Y – X) – C)/V
where: (Y – X) = weight of BSFTPM in mg (8(c))
C = average weight of three field blank filter sets carried through the procedure (8(a)), in mg.

Effect of Temperature on Drying Time of BSFTPM Content

As a first step, the drying time as a function of surface temperature for evaporating benzene was estimated as follows: Copper plates (in stacks) were placed on the hotplate, under the aluminum tray holding the 12 aluminum cups containing 10 mL of benzene each. This helped to control the temperature variation as shown in Table 2, which also records the time taken for complete evaporation.

At 100°C the time to evaporate 10 mL of benzene was found to be around 25 minutes.* For consistency, the temperature control is evident from Table 2. Controlling the surface of the commercially available hotplate to uniform temperature was not possible. An in-house constant surface temperature warmplate was constructed by our instrumentation section. This device has a unique feature of heating the air under the plate, using a sparkproof fan blower and thermistors for precise and uniform surface temperature (60°C), also a plate glass cover with fixed location for filter unit openings and a covered stainless steel exhaust outlet for carrying the volatile benzene into the fume hood duct, far away from the breathing zone of the analyst. This device facilitated our further investigations in the method development.

*Although the shorter time for evaporation of the benzene is desirable, it was found that a considerable weight of the BSFTPM material is lost at the higher temperatures, as shown in Table 3.

Table 2

Benzene Evaporation: Temperature vs Time

No. of Copperplates	Surface Temperature °C	Time of Evaporation (Min.)	
		$\bar{x}$	s
1	60	65	2.7
2	63	53	1.8
3	65	44	3.0

Table 3

BSFTPM Content vs Temperature

Temperature, °C	BSFTPM (mg)		
	n	$\bar{x}$	s
60	12	0.168	0.007
100	12	0.105	0.011

Weight Stability of Desiccated Aluminum Cups

The weight stability of aluminum cups used in the determination of BSFTPM is an important consideration in view of the very low TLV. Sixteen aluminum cups were cleaned, dried, desiccated and weighed as described in the method and then returned to the desiccator. Each cup was subsequently re-weighed five times over a period of seven days and returned to the desiccator between each weighing. The balance was calibrated daily using type S reference weights as in 4(c). The change in weight of each cup after each weighing is shown in Table 4. The

Table 4

Aluminum Cups – Change in Weight with Time in a Desiccator

Identity	Change in Weight (mg) Consecutive Weighings					$\bar{x}\Delta$(mg)	σ(mg)
	Day 1	Day 2	Day 3	Day 4	Day 5		
1	(+)0.002	(−)0.001	(−)0.008	(−)0.010	(+)0.003	0.0048	0.0040
2	(+)0.003	(+)0.006	(−)0.014	(−)0.009	(+)0.004	0.0072	0.0044
3	(−)0.007	(+)0.009	(−)0.011	(−)0.009	(+)0.001	0.0074	0.0038
4	(−)0.012	(+)0.007	(−)0.004	(−)0.010	(+)0.007	0.0080	0.0031
5	(−)0.014	(+)0.005	(−)0.007	0.000	(+)0.001	0.0054	0.0056
6	(−)0.012	(+)0.005	(−)0.013	(−)0.002	(+)0.002	0.0068	0.0054
7	(−)0.010	(+)0.001	(−)0.015	(+)0.006	(+)0.015	0.0094	0.0060
8	(−)0.013	(+)0.006	(−)0.024	(+)0.008	(+)0.020	0.0142	0.0077
9	(−)0.009	(+)0.003	(−)0.011	(−)0.004	(+)0.018	0.0090	0.0060
10	(−)0.001	(+)0.001	0.000	(−)0.008	(+)0.012	0.0040	0.0053
11	(−)0.009	(+)0.002	(−)0.003	(−)0.004	(+)0.012	0.0060	0.0043
12	(−)0.003	(−)0.008	(+)0.002	(+)0.009	(+)0.004	0.0052	0.0031
13	(−)0.006	(−)0.003	(+)0.006	(−)0.005	(+)0.004	0.0048	0.0013
14	(−)0.002	(−)0.003	(+)0.009	(−)0.004	(−)0.004	0.0044	0.0027
15	(+)0.005	(−)0.006	(−)0.003	(−)0.003	(+)0.002	0.0038	0.0016
16	(−)0.003	(+)0.008	(−)0.005	(−)0.004	(+)0.006	0.0052	0.0019

average weight change of 16 aluminum cups with a total of 80 re-weighings, over a period of seven days, is 0.001 mg. It is evident that change in weight in the consecutive weighings of the aluminum cups does not, on the average, significantly affect the procedural blank, as will be indicated later.

BSFTPM Weight Vs Temperature

At present there is no known standard reference material (SRM) available for BSFTPM. An in-house working standard was prepared as follows: Settled coke emission dust from strategic location in the coke oven battery was collected and extracted for four hours with benzene in a mini Soxhlet apparatus. The benzene extract was filtered through an HA Millipore filter and diluted to the mark with benzene in an amber coloured volumetric flask. Ten mL aliquots were pipetted into 12 pre-weighed aluminum cups placed on the aluminum tray. The study was carried out at temperatures of 60°C and 100°C. After complete dryness and an additional one hour on the warmplate at the respective temperatures, the aluminum tray, with the aluminum cups, was desiccated for four hours, and the cups re-weighed. Table 3 records the weight of BSFTPM vs temperature.

Table 3 demonstrates that BSFTPM content is considerably (62.5 per cent), lower at 100°C than at 60°C. For consistency, and in view of the OSHA/NIOSH methods specified temperature of 40°C, 60°C was preferred in the developed procedure instead of the 100°C of the Ontario MOL code.

Glass Fibre – Silver Membrane Combination Filters Vs Double Glass Fibre Filters

The NIOSH/OSHA methods required the use of a glass fibre filter with a silver membrane filter support for sampling of airborne coke oven emissions, and so does the Ontario MOL code. After extensive comparative tests by the AISI (American Iron and Steel Institute) Industrial Hygiene Analytical Subcommittee, a report[5] was submitted to OSHA recommending deletion of the silver membrane filter. Both OSHA and NIOSH reviewed the data and agreed that the silver membrane filter can be dispensed with in the sampling for BSFTPM.[6]

Section 17 of the Ontario Regulation Respecting Coke Oven Emissions permits the methods and procedures to vary from the codes issued by the Ministry of Labour, provided that the factors of accuracy and precision equal or exceed the factors in the code.

Hence the described method employs two pre-extracted fibre glass filters in the sampling train for the determination of BSFTPM.

Recovery and Precision

For lack of any standard reference material for BSFTPM it was thought desirable to focus on making an in-house monitoring standard, as described earlier. Ten mL aliquots from this standard were pipetted directly into the pre-weighed aluminum cups. Simultaneously, 10 mL aliquots were also pipetted into the centrifuge tubes containing pairs of pre-extracted glass fibre filters and taken through the described analytical procedure for determining BSFTPM, along with the procedure blanks using pairs of pre-extracted glass fibre filters.

Benzene (10 mL) was also pipetted into the aluminum cups to determine this blank component side by side. It was found to be 0.001 mg, not significant enough to affect the procedural blank. Recovery was calculated after subtracting the average procedure blank 'B' (0.013 mg) from the individual weight for standard with filters 'T', taken through the procedure, determined as a percentage of the arithmetic mean value of the standard 'S' and pipetted directly into the aluminum cup. The results are recorded in Table 5, which also shows consistent and acceptable precision. The procedure blanks are also both low and precise.

Table 5 **BSFTPM Precision and Recovery Tests (60°C)**

Std. (Direct) (S) Ind. Value (mg)		Std & Filters (T) (Procedure) Ind. Value (mg)		Filters Blank (Procedure) Ind. Value (mg)		Recovery %	
0.124	0.131	0.127	0.128	0.012	0.014	91.2	92.0
0.129	0.133	0.132	0.128	0.014	0.011	95.2	92.0
0.115	0.127 0.124	0.118	0.013	0.019	88.8	84.0	
0.118	0.121	0.124 0.131	0.131	0.018 0.009	0.005	88.8 94.4	94.4
n	8	9		9		9	
$\bar{x}$	0.125	0.127		0.013		91.2	
Δ	0.006	0.004		0.004		3.5	

Conclusions

The problems associated with the OSHA/NIOSH and the Ontario MOL code methods, in view of the very low TLV of BSFTPM (0.15 mg per metre cube), have been overcome in the described method by modifying the apparatus and equipment, and by streamlining the procedure. The actual temperature for evaporating the BSFTPM extract, as well as its uniformity across the warmplate,

was found to be crucial for consistent recovery of the BSFTPM content. Similarly, the establishment of procedure blanks was found to be very important. Hence, due allowance is made for carrying out an appropriate number of procedure blanks determination as specified. The average procedure blank is than subtracted to calculate the net BSFTPM content. The streamlined procedure also has a device that carries benzene fumes away from the breathing zone of the analyst. This has been found to be well below 1 PPM benzene in a six-hour period. The in-house working BSFTPM standard helps to monitor the accuracy of the determination. The method is both precise and accurate. Up to 128 BSFTPM determinations, using two warmplates, side by side, can be made by an analyst in a five-day week. The method has been in routine operation in our laboratory for four years.

Résumé

On décrit une méthode simple, efficace et exacte pour analyser la fraction soluble dans le benzène de la somme des particules rejetées dans l'atmosphère par les fours à coke. Les méthodes employées par l'OSHA et par le NIOSH, de même que celle décrite en vertu du code du ministère du Travail présentent des limitations analytiques quant à l'exactitude et à la précision en raison de la concentration maximale admissible très basse (0, 15 mg par metre^3). Cet article traite de ces limitations et présente une méthode de rechange viable, qui est non seulement exacte et précise, mais rapide et donc utile pour un nombre élevé d'analyses. La méthode mise au point est utilisée chez Stelco de façon régulière depuis quatre ans.

Acknowledgments

Grateful appreciation is expressed to our instrumentation section for designing and constructing the constant temperature surface warmplates, to Glenn Weston for helpful discussions, to Cheryl Jenson and Richard Baird-Kerr for experimental assistance and to Stelco Inc. for permission to publish this contribution.

References

[1]OSHA Safety and Health Standards (29 CFR 1910 – 1929), U.S. Department of Labour.

[2]NIOSH Manual of Analytical Methods, 2nd. ed. Vol 1; Method No. P & CAM 217, U.S. Department of Health, Education and Welfare, Publ. (NIOSH) 77 – 157 – A 1977.

[3]NIOSH Manual of Analytical Methods, 3rd ed. Supplement, Method: 5023, 1985.

[4]Code for Measuring Coke Oven Emissions, June 30, 1982, Ontario Ministry of Labour, Occupational Health and Safety Division.

[5]A Comparison of Ultrasonic and Soxhlet Extraction Methods for the Analysis of Coke Oven Emissions, AISI Industrial Hygiene – Analytical Subcommittee Report, Sept. 20, 1979.

[6]Breslin P, Director, Directorate of Technical Support, OSHA, Washington, D.C., Letter to AISI Industrial Hygiene Committee, May 17, 1982.

Recent Publications Available From the Government Book Store

Regulations	Regulation respecting Control of Exposure to Biological or Chemical Agents – made under the Occupational Health and Safety Act Ontario Regulation 654/86 as amended by O. Regs. 707/86 and 339/87
	Regulation respecting Ethylene Oxide – made under the Occupational Health and Safety Act Ontario Regulation 146/87
Support Literature	Designated Substances in the Workplace: A Guide to the Isocyanates Regulation
	Designated Substances in the Workplace: A Guide to the Acrylonitrile Regulation
	List of Occupational Health and Safety Consultants in Ontario

News and Notes

A Guide for the Structure and Administration of Occupational Health Services

Introduction

The *Occupational Health and Safety Act* provides a legal basis for the protection of workers exposed to hazards in the workplace.

This guide provides an overview of the structure and the administration of occupational health services. It is intended to aid employers in the establishment of new services and in the assessment of existing facilities.

Objectives of an Occupational Health Service

The objectives of an occupational health service are:

1. The protection of the health and well-being of the worker against the stressors and potential health hazards of the work environment.
2. The placement of the job applicant or current employee in work commensurate with his or her physical and emotional capacities, work that can be performed without danger to the worker or fellow employees and without damage to property.
3. The provision of emergency medical care for injured or ill workers.
4. The maintenance or improvement of the health of the worker through promotional, educational or informational activities (Health Education and Health Promotion).

Staffing Pattern and Reporting Relationship

This varies with the breadth of services offered and the responsibilities held.

In small businesses (1 – 50) employees), occupational health services may be provided as an 'out-of-plant' service such as through industrial medical clinics (fixed-site or mobile). The plant manager should arrange for the physician to visit the plant or place of work so that the physician can actually see the working conditions and become acquainted with at least some of the supervisors and members of the joint health and safety committee. The frequency of visits after the first visit should be determined by the nature of the work and major changes in materials or processes. If significant hazards exist in the

work environment, the physician should tour the workplace every one or two months.

Remuneration of the physician may be on a fee-for-service basis, including hourly charges for visits to the workplace. If the services provided are frequent, a retainer or salary may be desirable for both parties. If the physician is associated with the company on a part-time basis and a nurse is available, she should report to him funtionally on professional matters, but may report to the personnel manager administratively.

In larger organizations, the physician should report at his or her facility to a senior member of management.

The occupational health nurse, if there is a full-time physician, should report both administratively and professionally to the physician. The reporting relationships of other health professionals, including hygienists, should be determined on an individual company basis.

A working relationship should exist between the health service and those departments that have jurisdiction over health insurance and workers' compensation.

Role of the First Aid Worker

The first aid worker has an important role in industry. Every establishment should have one or more such trained persons as required by the First Aid Regulations made under the *Workers' Compensation Act*. It is essential that the persons assigned to be responsible for first aid – in addition to their regular jobs – be prepared to function and hold current first aid certificates from a recognized agency, e.g. St. John Ambulance.

A work protocol should be developed for first aid workers. All care provided by the first aid worker should be recorded and included in the employee medical record.

The Occupational Health Unit Record System

A chronological record on each person visiting the health service should be initiated with the first visit. The record should be a compilation of all the data acquired in the process of investigating and assessing an employee's health.

Medical records are the responsibility of the examining physician. The occupational health nurse may be delegated to handle the records while maintaining their confidentiality. If the nurse uses the records, the recording of activities or action must be clear and dated.

Records for the purpose of Designated Substance Regulations should be structured as outlined in the Code for Medical Surveillance and should be kept separately from other records to afford easy identification and record

retention for the statutory period, i.e. 40 years or 20 years from the last entry, whichever is longer. (Section 15 of the Designated Substance Regulations.)

Disposal of Records

1. Records for the purpose of Designated Substance Regulations shall be forwarded to the Chief Physician, Occupational Health Medical Service, Ministry of Labour, if the company ceases operations or when the physician is no longer with the company and no successor has been appointed.
2. Records for non-designated substance exposures (voluntary medical programs) shall be disposed in accordance with the requirements of the *Health Disciplines Act*.

Disaster Plans

In developing an overall contingency plan for a company, management must consider the role of the occupational health service.

The occupational health service should develop a disaster plan manual. The manual should include the following provisions:

1. Names, addresses and phone numbers of staff members, including the name and plant location of all first aid attendants.
2. Name of management contact for communication purposes.
3. Duties and responsibilities of each staff member.
4. Company policy regarding the use and payment for the transportation of ill or injured employees (taxis, ambulances, special carriers).
5. Notification procedures, considering the following contacts:

– ambulance and emergency services
– hospitals
– Ministry of Labour – regional office
– Ministry of Environment – regional office
– medical officer of health – office
– workers' examining physicians – office

6. Relevant information on the toxicity and first aid procedures for all chemicals used or produced in the workplace. To complete the manual on toxicity of chemicals, information may be obtained from local Poison Information Centres and from the Canadian Centre for Occupational Health and Safety in Hamilton (toll-free number).
7. Requirements for practice sessions and regular maintenance of emergency equipment.

8. Establishment of a working relationship with the community hospitals, the police, fire departments and ambulance services.

Physical Plant

The health unit(s) should meet the following minimum recommendations:

a) The location in the workplace should be selected to allow easy accessibility and convenience.
b The functional layout should include a reception/waiting area, treatment room, recovery/observation room/a doctor's and/or nurse's office/washroom.
c) The space allowed may be calculated on the number of workers.

e.g. 0.1 m^2/employee for first 1,000

0.05 m^2/employee for second 1,000

0.025 m^2/employee for over 2,000

d) The space required for a first aid room is approx. 35m^2.
e) Material and equipment as necessary to provide medical care.

The 12th Semi-Annual Intensive Workshop in Industrial Hygiene. University of Toronto.

Monday, September 26, 1988 to Friday, September 30, 1988

This workshop is designed for those who, for the following reasons, would benefit by taking the course:

- to increase knowledge of their specialization in occupational hygiene;
- feel the need for a general refresher course;
- for recent entrants to the hygiene field who wish to broaden their background knowledge of occupational hygiene

The panel of lecturers includes Dr. John Steel, Dip.Occ.Hyg., from the Dept. of Occupational Health and Hygiene, Medical School, University of Newcastle-upon-Tyne, United Kingdom, personnel from the Ontario Ministry of Labour, and faculty and staff of the University of Toronto. The expertise of the speakers covers all relevant aspects of hygiene, risk assessment, human factors engineering, toxicology, occupational medicine, and occupational health and safety legislation. A hands-on equipment demonstration and monitoring round-table are included in the workshop.

The Industrial Hygiene and Hazard Control Engineering Program of the University of Toronto presents the workshops bi-anually. Professor J.W. Smith, Ph.D.,C.Eng.,

C.I.H., chairman of the Department of Chemical Engineering and Applied Chemistry is the program co-ordinator.

Enquiries should be addressed to:

Secretary of Occupational Health and Safety,
Department of Chemical Engineering and Applied Chemistry,
University of Toronto,
Toronto, Ontario
M5S 1A4.
(416) 978-3066

Coming Events

July 11 – 15, 1988	Society of Occupational Medicine, Annual Provincial Meeting: New Technology – New Challenges. GUILDFORD, ENGLAND. For further information, contact: Dr. I.M. Dawson, Society of Occupational Medicine, London Group, 6 St. Andrew's Place, Regent's Park, London, England, NW1 4LB.
August 1 – 5, 1988	International Ergonomics Association 10th Congress, SYDNEY, AUSTRALIA. For further information, contact: Secretariat IEA88, PO box 380, Spit Junction, NSW, Australia, 2088.
August 12 – 16, 1988	First Symposium on Biological Effects, Hazards and Protection from NonIonizing Radiation in Outdoor Applications. STOCKHOLM, SWEDEN. For further information, contact: NIRO 87, c/o KREAB Congrex, Box 5619, Stockholm, Sweden, S-114 86.
August 15 – 18, 1988	ICCEF 88. Third International Conference on the Combined Effects of Environmental Factors, FINLAND. For further information, contact: Chairman, Dr. Olavi Manninen, ICCEF 88, Secretariat, c/o Dept. of Public Health, Medical Faculty, University of Tampere, P.O. Box 607, Tampere, Finland, SF-33101.
August 16 – 18, 1988	Sixth International Symposium on Epidemiology in Occupational Health, STOCKHOLM, SWEDEN. For further information, contact: Sixth International symposium on Epidemiology in Occupational Health, c/o Stockholm Convention Bureau, Box 6911, Stockholm, Sweden, S-102 39.
August 21 – 25, 1988	Noise '88 – the 5th International Congress on Noise as a Public Health Problem – STOCKHOLM, SWEDEN. For further information, contact: Noise '88, c/o Reso Congress Service, Stockholm, Sweden, S-113 92.

August 22 – 27, 1988	Twelfth International Conference on Atmospheric Aerosols and Nucleation. VIENNA, AUSTRIA. For further information, contact: P.E. Wagner, Institut fur Experimental Physik, Universitat Wien, Strudlhofgasse 4, Vienna, Austria, A-1090.
August 23 – 26, 1988	VIIth International Pneumoconioses Conference, PITTSBURGH, U.S.A. For further information, contact: Robert E. Glenn, Conference Chairman, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Road, Morgantown, West Virginia, U.S.A., 26505-2888.
August 30 – September 1, 1988	Inter-Noise 88. 17th International Conference on Noise Control Engineering. AVIGNON, FRANCE. For further information, contact: Inter-Noise 88, Secretariat, BP 23, Senlis Cedex, France, F60302.
September 5 – 8, 1988	CIB Conference – Healthy Buildings '88. STOCKHOLM, SWEDEN. For further information, contact: The Swedish Council for Research, S:t Goransgatan 66, Stockholm, Sweden, S-112 33.
September 5 – 9, 1988	Fourth International Conference on Nickel Metabolism and Toxicology. ESPOO, FINLAND. For further information, contact: Fourth International Conference on Nickel Metabolism and Toxicology, c/o Institute of Occupational Health/Ms Seija Toro, Topeliuksenkatu 41 a A, Helsinki, Finland, SF-00250. Phone (+358 0) 474 71, Telex: 121394 tltx sf occuphealth, Telefax 414634.
September 20 – 23, 1988	Second International Symposium on Ventilation for Contaminant Control, Ventilation 88, LONDON, ENGLAND. For further information, contact: British Occupational Hygiene Society, 1 St. Andrew's Place, Regent's Park, London, England, NW1 4LB.
September 25 – 28, 1988	Occupational Medical Association of Canada – Annual Meeting. QUEBEC CITY, CANADA. For further information, contact: Dr. F. Mills, Corporate Medical Director, John Labatt Ltd., P.O. Box 5870, London, Ontario, Canada N6A 5L3.

September 25 – 28, 1988	Seventh International Congress on Aerosols in Medicine. NEW YORK. U.S.A. For further information, contact: University of Rochester Medical Centre, Box 677, Rochester, New York, U.S.A., 14642.
October 5 – 8, 1988	ICOH Scientific Committee – Second International Workshop on Personal Computer and Data Banks in Occupational Health, PALMA DE MALLORCA, SPAIN. For further information, contact: Dr. Jose Sevillaa, Mutua Balear, c/. Obispo Çampins 4, Palma de Mallorca, Balear Islands, Spain.
October 17 – 20, 1988	Rocky Mountain Occupational and Environmental Health Conference (VIII). PARK CITY, UTAH, U.S.A. For further information, contact: RMCOEH/Continuing Education, Registration Co-ordinator, University of Utah, Bldg. 512, Salt Lake City, Utah, U.S.A. 84112.
October 17 – 21, 1988	Ontario Occupational Health Nurses Association Conference. HAMIILTON, ONTARIO, CANADA. For further information, contact: J. Dalgetty, Medical Department, Stelco Inc., Box 2030, Hamilton, Ontario, Canada, L8N 3T1.
October 24 – 26, 1988	International Conference on Industrial Health. KITAKYUSHU, JAPAN. For further information, contact: T. Okuba, M.D., Institute of Industrial Ecological Sciences, University of Occupational and Environmental Health, Yahata Nishi Ku Kitakyushu 807, Japan.
October 24 – 28, 1988	International Conference on Ergonomics, Occupational Safety and Health and the Environment, BEIJING, CHINA. For further information, contact: Conference Administrator, ICE-O-SHE, Darling Downs Institute of Advanced Education, P.O. Box 44, Darling Heights, Toowoomba, Qld, Australia, 4350.
November 18 – December 2, 1988	International Conference on Occupational Hazards in Agriculture and Industry. CAIRO, EGYPT. For further information, contact: CPHA International Health Secretariat, 1335 Carling Avenue, Suite 210, Ottawa, Ont., Canada, K1Z 8N8.

August 28 – September 1, 1989	CLIMA 2000 – Second World Congress on Heating, Ventilation, Air Conditioning and Refrigeration. SARAJEVO, YUGOSLAVIA. For further information, contact: CLIMA 2000, Masinski Fakultet, Prof. Dr. E. Kulic, 71000 Sarajevo, Omladinsko Staliste 66, Yugoslavia.
October 3 – 6, 1989	Occupational Medical Association of Canada – Annual Meeting. HALIFAX, NOVA SCOTIA, CANADA. For further information, contact: Dr. F. Mills, Corporate Medical Director, John Labatt Ltd., P.O. Box 5870, London, Ontario, Canada, N6A 5L3.

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